Dynamic Maximum Operating Level for Safe and Optimal Reservoir Management

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Presentation Content

- **The need for Safety Operating Level Constraints (SOLC)**
- **What is a SOLC and why use it ?**
  - The importance of an optimized SOLC
- **Evaluation of a SOLC**
  - Choosing a risk level
  - Determining the PMF
  - Establishing Operating Level Constraint that Ensures Safe Operation
- **Evaluation of dynamic SOLC**
  - The Concept of Dynamic SOLC
  - Determining Most Severe Spring Flood Events
- **Gains and conclusions**

The need for a Safety Operating Level Constraint (SOLC)

- To ensure dam and public safety in the case of extreme but possible meteorological events, with an acceptable risk level

What is a SOLC ?

- It is an **operating level constraint** that would allow for storage to be available (in addition to spillage capacity) to ensure dam safety;

- In addition, **dynamic SOLC** take into account the actual hydrologic state of the watershed, which in turn also affects the estimate of the flood event considered for dam safety purposes.

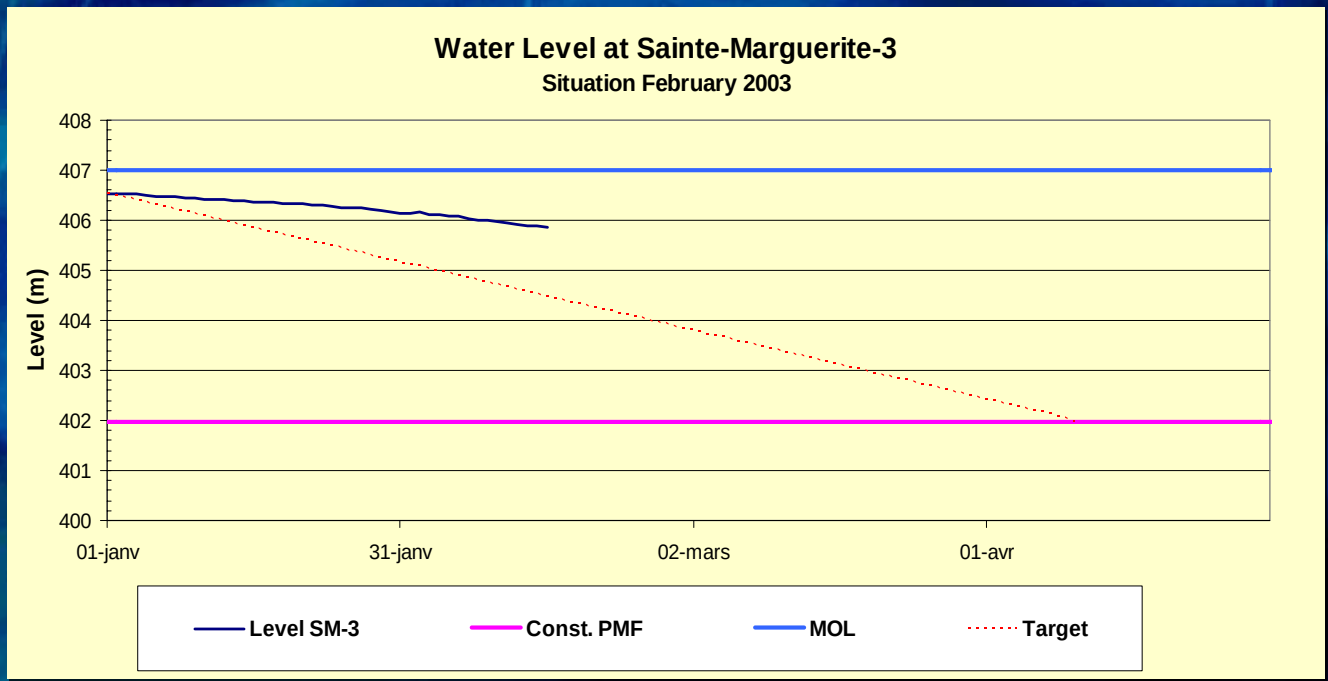
What is a SOLC ?

- An overestimated SOLC will result in too much risk (and possible catastrophic results)
- An underestimated SOLC will result in non-optimal generation losses in the form of spillage or energy losses.

What is a SOLC ?

Example of Sainte-Marguerite-3:

- In 2003 the water level at the beginning of the winter was high
- With only one unit available, it was difficult to lower the reservoir to reach the safety operating water level constraint without major spillage



Evaluation of a SOLC – Choice of a risk level

- **1. Choice of a risk level**
  - Probable Maximum Flood (1987, USBR)

    "Flood representing maximum flow conditions resulting from the most severe combination of hydrological and meteorological conditions **reasonably** possible for the drainage basin under study"

  - Or any other chosen risk level (1/10 000 years, 1/ 1000 years, etc.).

Evaluation of a SOLC – Determining PMF

2. Determining the PMF

The Deterministic Approach : Calibrated rainfall-runoff model, with 3 major meteorological inputs:

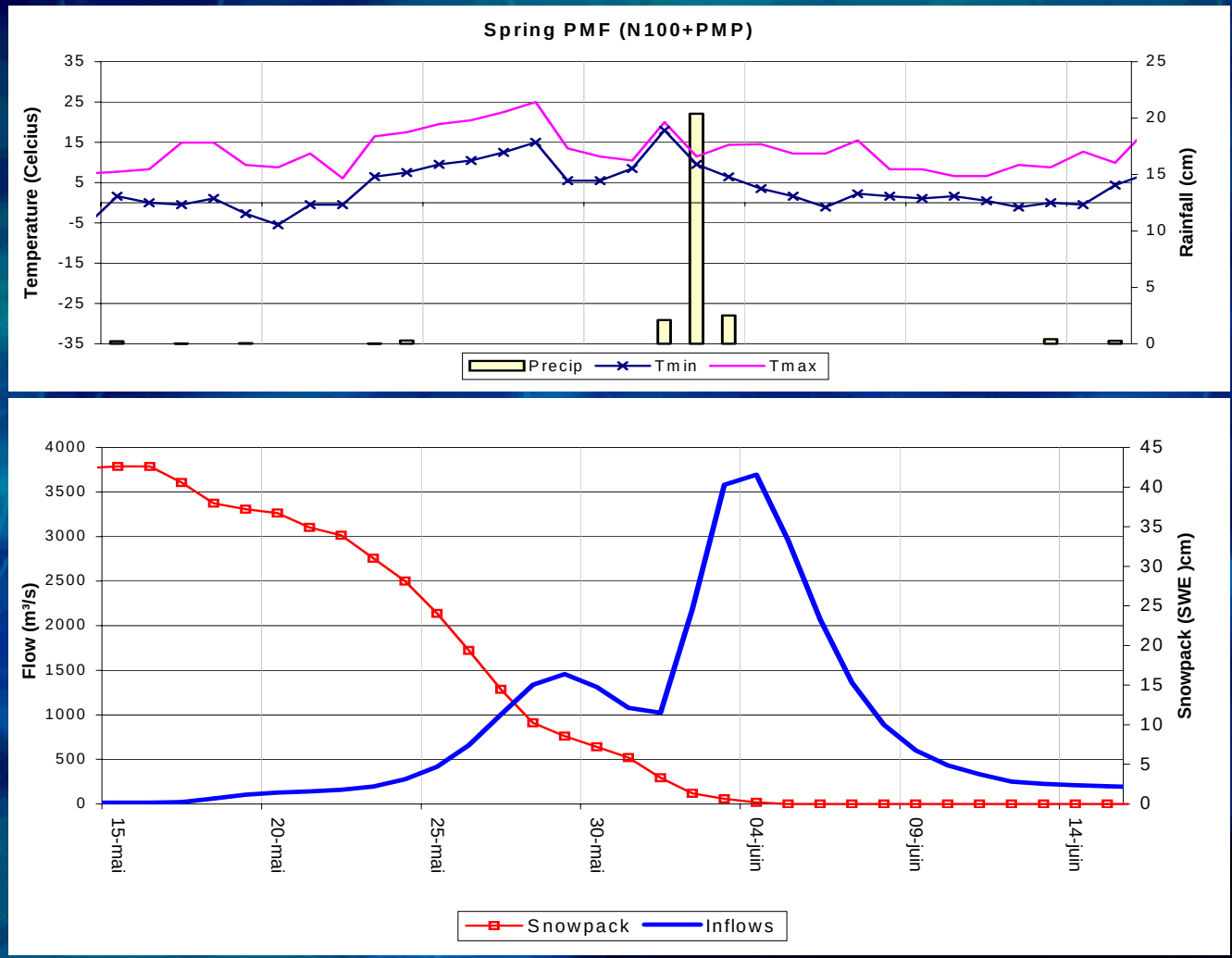
- rainfall event;
- snow accumulation
- temperature series.

We consider 2 spring scenarios

- PMP + N100
- P100 + (MPSA)

PMP = Probable Maximum Precipitation
P100 = Precipitation Return Period 100 years
N100 = Snowpack Return Period 100 years
MPSA = Maximum Probable Snow Accumulation

Evaluation of a SOLC – Determining PMF



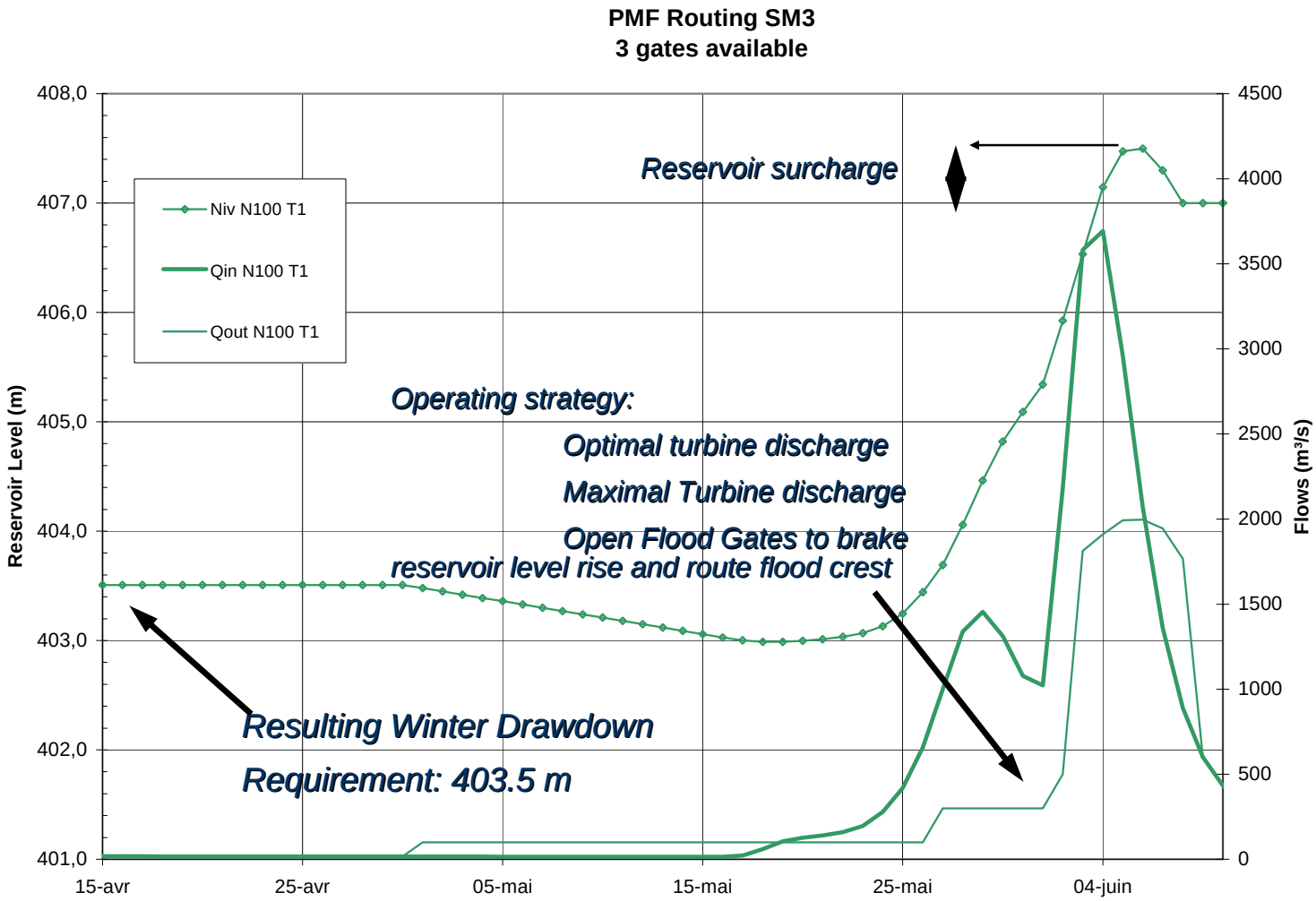
Evaluation of a SOLC - Establishment

3. Establishing an Operating Level Constraint that Ensures Safe Operation

- Routing Hydrograph using Water Management Rules
  - Example of rules
    - Using all the spillage capacity after the PMP
    - The units are not available

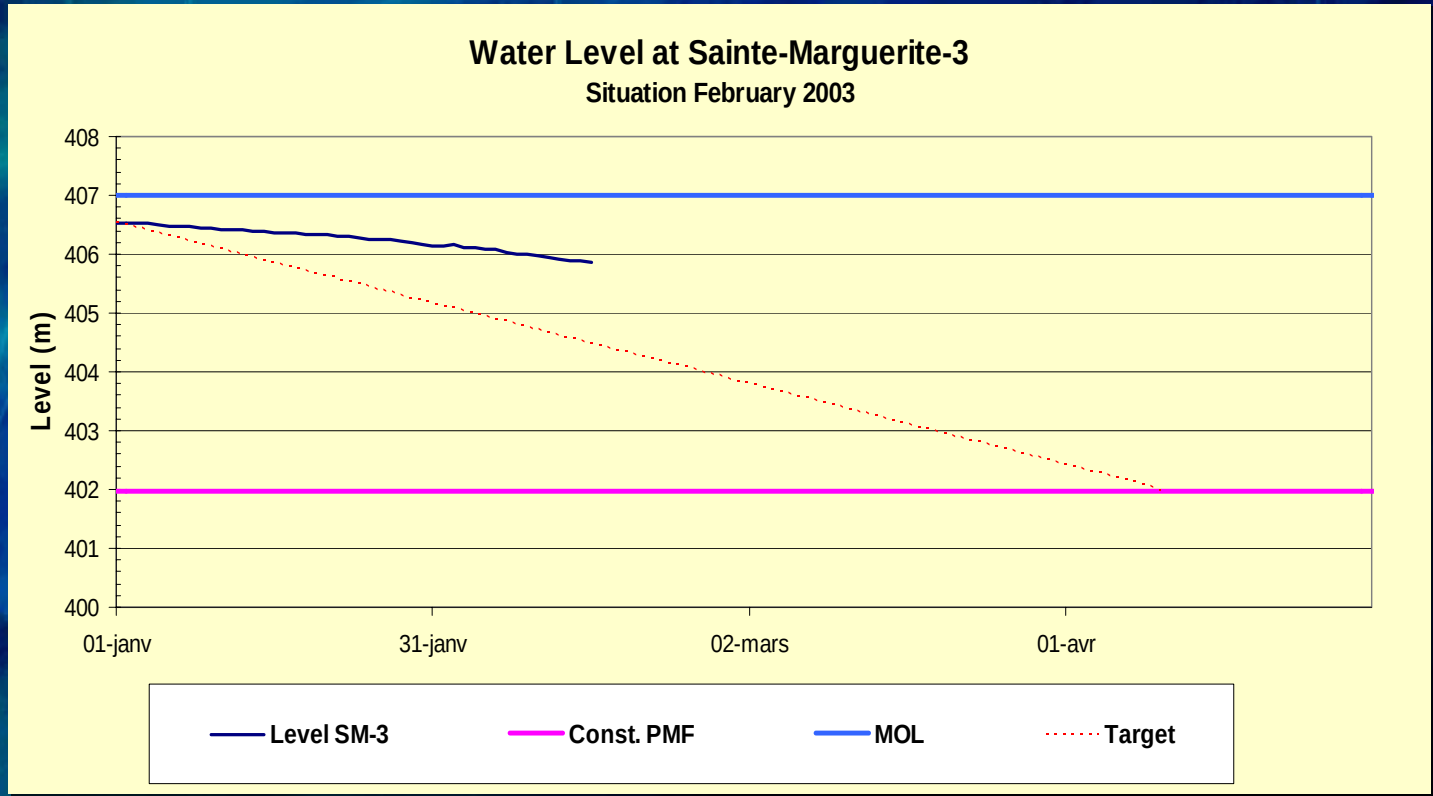
- Respecting Reservoir Surcharge Level

Maximum Operating Level Constraints



Example of Sainte-Marguerite-3:

- Is it necessary to lower at this level?



Evaluation of dynamic SOLC - Concept

Spring PMF = PMP + N100

BUT…..

We don't reach the N100 each year

- As we get closer to spring, we can forecast with increased accuracy the expected snowpack at freshet

If we estimate the most severe spring events for a range of snowpacks, we can adjust the reservoir level constraints accordingly

Evaluation of dynamic SOLC

Most Severe Spring Flood Events

To Determine Most Severe Spring Flood Events:

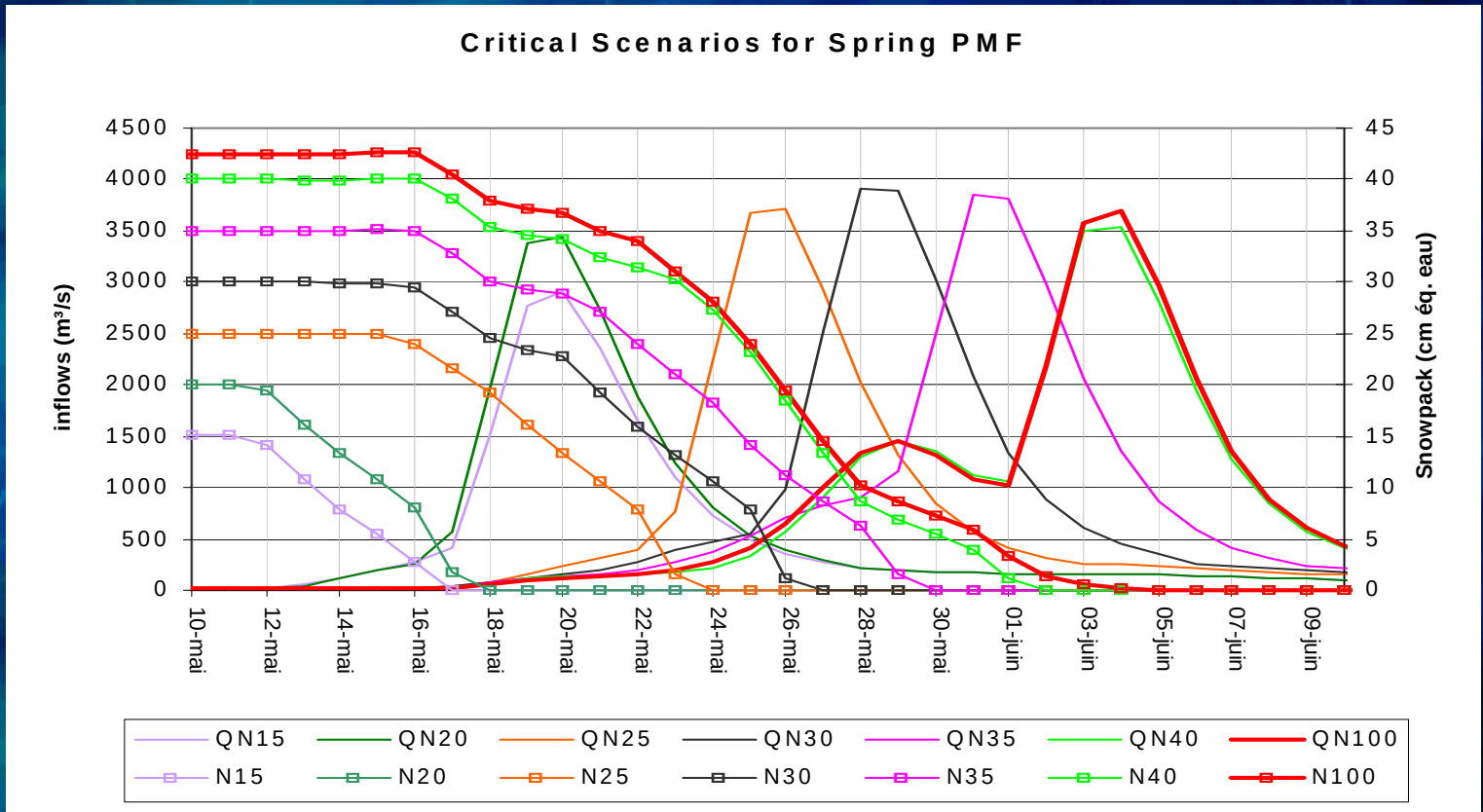
- Modify snowpack over a range of possible values;
- Adjust the timing of the PMP and the corresponding temperature sequence to recreate a PMF-type situation

Evaluation of dynamic SOLC

Most Severe Spring Flood Events

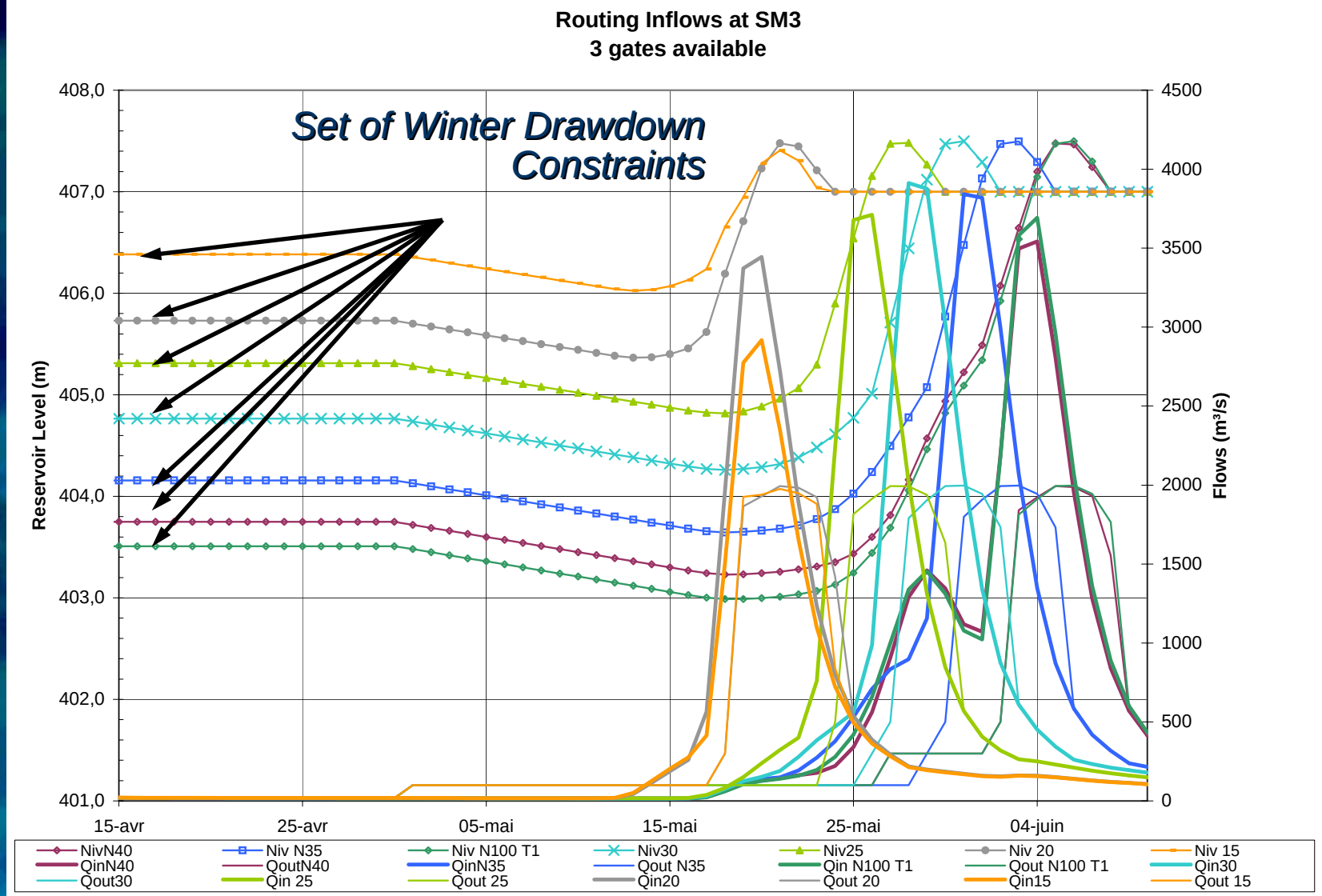
Developing Inflow Scenarios for a range of Snowpack Conditions

Sainte-Marguerite-3

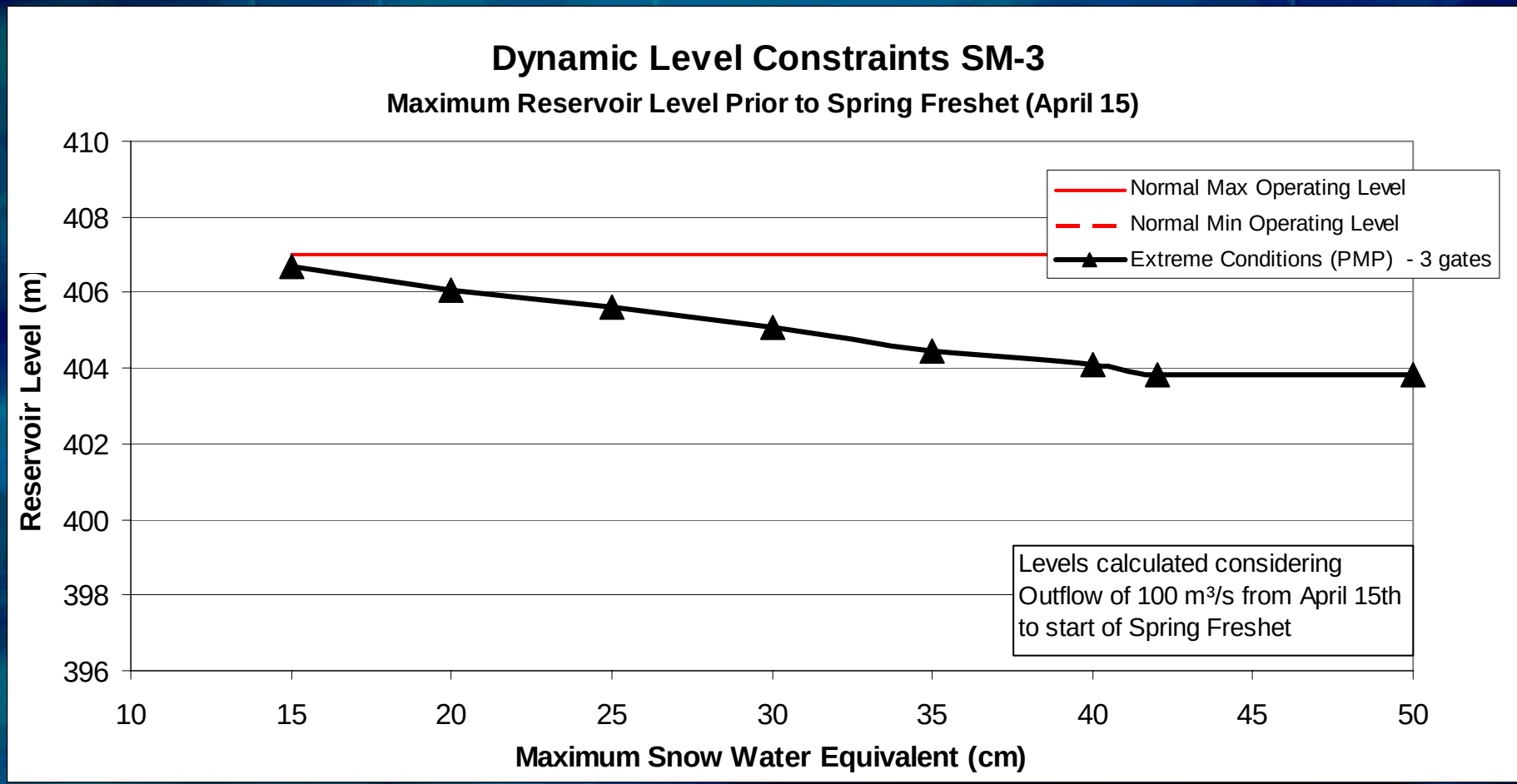


Evaluation of dynamic SOLC

Most Severe Spring Flood Events

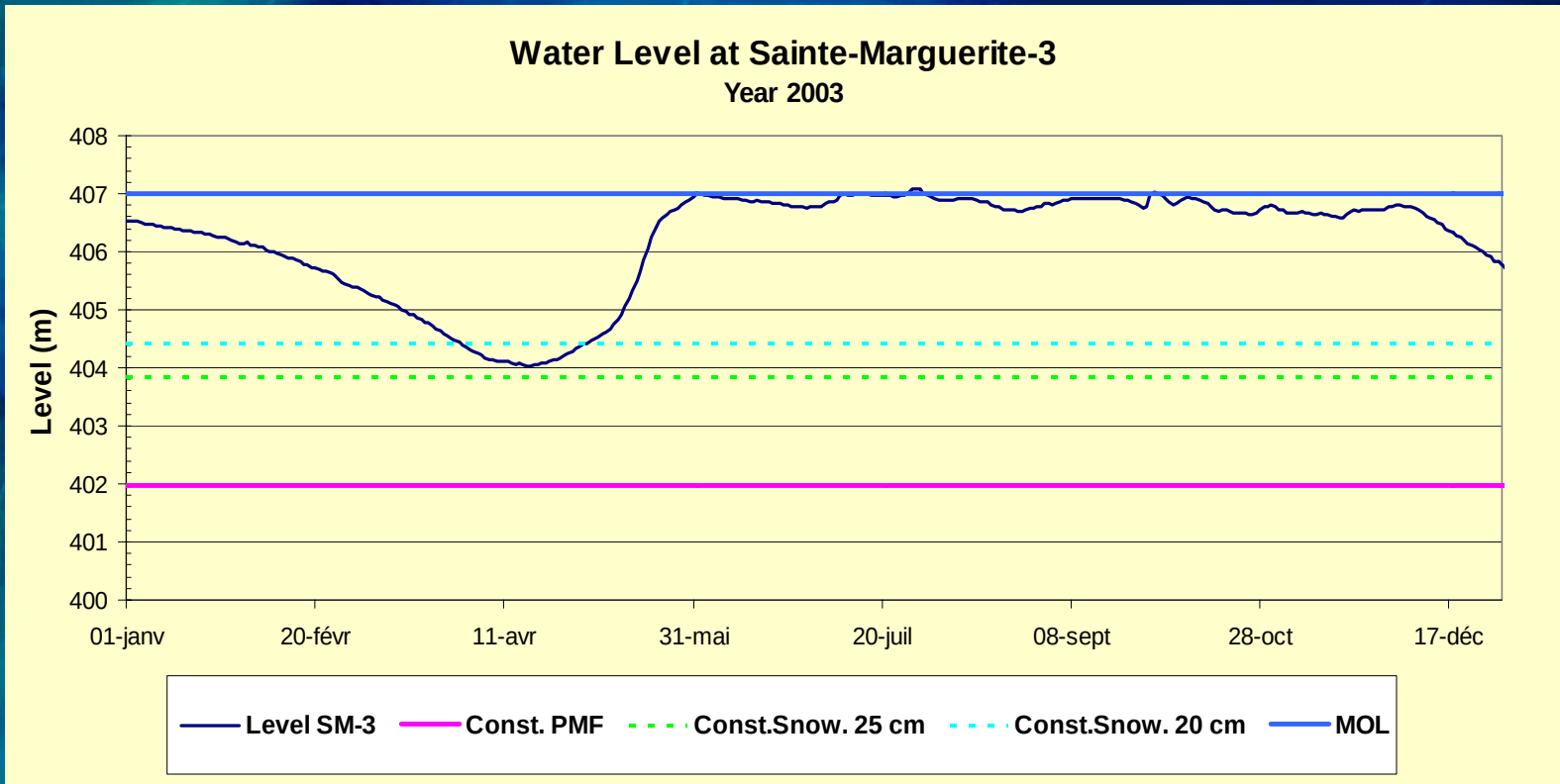


Dynamic SOLC



Gains and Conclusions

- **Example of gains:**
  - In 2003 in Sainte-Marguerite-3, with only one unit commissioned, it was difficult to draw the reservoir down to reach the SOLC to safely evacuate the PMF without major spillage.
  - With a dynamic SOLC, we saved 500 hm^3 or 400 GWh



Gains and Conclusions

This approach is useful:

- **To avoid spilling unduly**
- **To maintain a higher reservoir level.**

  While maintaining an acceptable risk level.